Close-Out Report

on the

Department of Energy
Review Committee Report

on the

Review

of the

D-Zero Detector Upgrade

June 7, 2000

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6/7/00 9:00am

1.1 Silicon Detector System

Findings

- The design of the D0 Silicon Microstrip Tracker (SMT) has been split into two halves, South (SMT-S) and North (SMT-N), along the beam direction, resulting in the accrual of substantial time contingency. This action, along with substantial other planning, addresses recommendations 3,4, and 5 from the last review in November, 1999. Other actions have addressed the remaining recommendations, 1 and 2.

- A large number of silicon detector assemblies have been produced: about 530 are built, and 440 are ready for installation; an average of 12 assemblies per week have been built since the last review. To operate the SMT, 768 functioning assemblies are needed. D0 projected that 900 assemblies would be produced by now. Assembly production milestones have slipped 2 to 4 months over the past 7 months. The cause appears to be delays in the delivery of parts. D0 estimates that 25 assemblies per week must be built and made ready for installation to meet the Mar. 1, 2001 startup.

- About 15% of the sensors, or about 100 sensors, must be acquired to complete all detector assemblies.

- The population of HDI's (High Density Interconnects) at Promex has recently become unreliable.

- The order for production of the interface cards has not yet gone out; about $290,000 remains in the balance for that task.

- One and one-half barrels and about 2.5 F-disks have been populated with detector assemblies. A total of 6 barrels and 12 F-disks, as well as 4 H-disks, are needed to complete the SMT. The first barrel completion occurred 5 months later than projected at the last review. In addition to the assembly delays, the mastering of the population procedures caused one-time-only delays.

- A test involving the readout of 10% of the final detector, involving some 80,000 channels, is planned to commence 6/29/00.

- In spite of the delays mentioned, the date projected for completion of the SMT has changed by only 1.25 months.

- In effect, the principal fallback is to delay SMT-N installation until a possible Tevatron downtime late in 2001.

Comments

- We commend the D0 collaboration on their innovation of splitting the SMT into halves, and on the substantial installation planning that they have completed.

- We commend the D0 collaboration for their successful production of hundreds of silicon assemblies, as well as the population of 1.5 barrels and 2.5 F-disks.

- We acknowledge that the slippage of milestones since the last review can be absorbed by the rearrangement of the assembly procedure enabled by splitting the SMT, and by changes in testing plans. Nevertheless, the slippage alarms us.

- The sensor delivery rate necessary for timely completion of the SMT is consistent with prior achievements.

- The HDI's and low-mass cables are significant sources of uncertainty. Although Honeywell (formerly Allied Signal) has produced the low-mass cables at the rate needed for timely completion of the SMT, only about 25% of the number of cables needed are currently on hand. Because the low-mass cables are necessary for installation, and because >80% of other components necessary for installation are on hand, we are concerned.

- The absence of interface cards should not substantially delay the installation of the SMT; nevertheless, the interface cards are essential for the successful readout of the SMT. Because the interface cards are about 4 months behind the schedule presented at the last review, and because the production order had not been finalized, we are concerned.

- The omission of one-half of the SMT would have major impacts on the physics capability of D0 during the first year of Run 2. In effect, the first segment of D0 operation would become an engineering run.

- The management of the SMT is effective.

- The current schedule for completion and installation of one-half of the silicon detector, SMT-S, is highly credible and likely to succeed. The current schedule for completion and installation of the second half, SMT-N, is optimistic.

Recommendations

- By July 1, the FNAL business office should complete contracts for the delivery of the final sensors.

- By July 1, station a D0 collaborator at Promex to monitor the population of the HDI, and establish a reportable milestone of HDI population and testing completion.

- By July 1, establish reportable milestones for 1) completion (including ablation, population, and coax attachment) of low mass cables for SMT-S and 2) completion of low mass cables for SMT-N.

- By August 1, revise the present silicon fallback plan to include consideration of the omission of SMT-N until a future Tevatron shutdown. Compare the physics impacts of this option to other possibilities, including the omission of the two end barrels and 4 F-disks. Evaluate the feasibility, and the schedule and manpower impacts, of these options.

1.2 Fiber Tracker

Findings

- As of May 26th, the winding of optical fiber ribbons on the 8 individual cylinders for the fiber tracker and the nesting of the cylinders into the final assembly has been completed. The CMM survey of the fiber positions shows that all mechanical specifications have been achieved in the completed tracker. The distribution of r-φ positions in axial layers are good to ±33 μm sigma of nominal. The residual stereo angle for these layers was found to be 100 μm end-to-end, well within the 150 μm specification driven by tight trigger requirements. This is good news for the L1 trigger, which can proceed as originally designed.
- The next step for the tracker is installation into D0 about June 16th. This will be followed during the period Aug. 15-Sep 15 (Sep 15-Oct 15) by installation on the south (north) face of D0 of the clear optical waveguides, which carry light signals from the detector to the VLPC readout modules. Unfortunately, the fabrication of the full complement of 340 waveguides has just begun, with only 30 available at this time. Since waveguide installation must precede SMT cabling, it is critical that waveguide production be completed in a timely fashion. This means that the south-side complement of 150 waveguides must be produced by Aug 15th, and the remainder by Sep 15th. All components for the waveguide fabrication are presently available, and all technical issues in their manufacture have been resolved.
- There is essentially no direct experience with the actual installation of waveguides. Extensive work has gone into the planning for the layout on face of the detector. The one-month period allotted to mounting each half of the detector is based on the assumption of 2 waveguides/shift/crew x 2 crews/shift x 6 days/week operation.
- Completion of the VLPC assemblies is underway, with 10 modules completed to date. This is projected to increase to 50 by Aug 15th, when the first waveguides are scheduled to be installed. All components for the VLPC modules are in hand, with the exception of flex circuits, of which 850/2000 are available. The remainder is to be delivered at a rate of 100/week. Projected completion date for the VLPC modules is now Oct 13th.
- The Anolog Front-End (AFE) boards have proven to be difficult and challenging to design, as they combine sensitive analog front-ends with trigger and SVX outputs in a layout severely constrained by the size of the main components. Recently, there has been considerable progress in understanding problems with noise and threshold variation, leading to a final layout ready for production. The first 10 articles should be available in about 4 weeks, allowing a confirmation of the latest layout design.

Comments

- The Fiber Tracker team is to be congratulated for completion of the main assembly. This is an outstanding achievement, as the instrument represents a unique and innovative tracking system with a wealth of technical challenges encountered in its development. The completion of the device is a major milestone for the D0 project, representing the culmination of many years of research and development, design, planning, and preparation.
- The projected fabrication rate of 25 waveguides/week appears to be consistent with experience to date, so that the anticipated completion date of Aug 15th for the full complement appears feasible. Since only 50% of these are required on Aug 15th, it quite likely that installation of the waveguides can commence at that point.
- While the estimated time required for installation of waveguides appears to be conservative, the regions of the waveguides around the curved connectors are fragile, so some problems could be encountered here.
- If the final AFE boards do not achieve the desired 2 photoelectron front-end sensitivity, there appears to be little room for further improvement in board layout. There are fallback positions, involving 7/8 logic in the trigger design, but these would involve a four-fold increase in the number of FPGAs and a substantial increase in cost and complexity for the trigger. Early results on the testing of the 10 first article boards will be very important in resolving this question.

Recommendations

None

Cost

Findings

The D-Zero project developed a new bottoms-up cost estimate for M&S in the February-March 2000 time frame. The total cost for M&S, the Solenoid, and contingency, at $48,490k, is an increase from the November 1999 review. This change is mainly due to net increases in the silicon and fiber tracker WBS's identified since the previous review, and adjustments to the project contingency. A change control action submitted to DOE for these changes was approved on 4/24/00. Overall, 93 percent of the total costs (without contingency) have been obligated, as indicated below.

M&S and Solenoid Costs
(In thousands of then year dollars)

	November 1999	April 2000	Changes	Obligated	Estimate to Complete
M&S	40244	41593	1349	38508	3104
Solenoid	4975	4886	-89	4886	0
Contingency	635	* 2011	1376	0	2011
Total	45854	48490	2636	43394	5115

Costs for operating salary, wages and fringes, including contingency, is estimated as $22.1 million through FY 2001 in then year dollars. This includes a change request submitted and approved by the lab on 3/20/00.

Comments

The contingency remaining for the M&S and Solenoid costs at * $2,011k is 65 percent of the estimate to complete. The project indicated (and the committee concurred) that this level of contingency is adequate to successfully complete the project.

Recommendations

None.

* $1,532 - 49%

D0 Schedule, Installation and Commissioning

Findings:

Opportunities for re-optimizing the installation schedule, resulting in some schedule float (time contingency), came about during the Director's Review of the Installation schedule in December.

One of the more significant ideas that came out of the Installation schedule workshop was the concept of cutting the SiDet (SMT) in half (in Z). The decision to adopt this idea has several benefits:

a) Adds some time contingency to the schedule

b) Allows early (end to end) commissioning

c) Allows maintenance of SMT in the Collision Hall

The collaboration/management is using the schedules - updating them regularly. A plot was shown that indicated that ~90% of the "major" milestones have slipped. A 10% test of the Si Detector (SMT) is planned. This is an "end-to-end" test of a major fraction of the whole that should give opportunity to find and solve problems early.

Conventional systems in the hall (power, cooling water, gas systems, safety systems, interlocks, racks, and so forth) are being refurbished and upgraded. The rate at which these elements are progressing appears to be adequate to meet the commissioning schedule of the detector subsystems.

The process of obtaining operational readiness clearances has begun. This has to be completed for each indirect subsystem. An addendum to the Safety Assessment Document (SAD) is being written. There are no new hazards introduced in the upgrade - similar systems, just more of it.

The commissioning effort has made a good deal of headway. In addition to the technical accomplishments, weekly commissioning meetings are being held and commissioning priorities are being integrated into installation plans. The commissioning coordinator (J. Yu) appears to have a solid grasp on what's needed and has adequate access to the resources he needs to keep the commissioning effort moving forward.

Schedule, Installation and Commissioning

Comments

- The slip of many of the milestones is a concern and will likely result in additional pressure on the Installation and Commissioning schedule and risk to completion by March.
- Both Installation and Commissioning appear to be in fine shape, with appropriate leadership, resources and planning.
- The decision to slice the SMT in half was a good one and gives DZero some much needed schedule float.
- The early commissioning tests that have begun and are planned for the near future will pay large dividends in time and should result in a much more efficient commissioning run for DZero beginning in March 2001.

Recommendations

- Don't give away all your schedule float up front.

Fallback Plans

Findings:

A relatively complete fallback plan has been developed and documented (DZero note 3724). Simulations of the physics impact of descoping options were also completed for the DZero Upgrade tracking systems.

The fallback plan for the silicon system (SMT) was summarized during the review as:

1) Barrel - small angel: install detectors with imperfections
2) Barrel - 90o: install detectors w/ 1-2% bad channels
3) F-disks: eliminate disks 3 and 10 in the assembly

Item 1 has already been adopted as a result of the documented June 1 Critical Decision date.

The fallback plans for the Fiber Tracker, Tracking and Calorimeter Electronics, Muon and Trigger systems were not presented during the review even though they are documented in the above referenced DZero note.

Fallback Plans

Comments:

- The ultimate Fallback plan for the silicon system is not in the document but it was discussed. The plan for delaying installation of SMT-North until after the beginning of Run II should become part of the documented plan. An Assessment of the physics impact, should this option be exercised, should also be completed.
- There appears to be a great reluctance within DZero to enact any part of the fallback that entails descope of detector components. There also appears to be greater willingness to utilize schedule float up front. Utilizing schedule float at this point adds significant risk to completion on March 1, 2001.

Recommendations:

- Unless compelling reasons exist, enact some of the descope plans should decision triggers occur prior to eliminating schedule float.